ENVIRONMENTAL MANAGEMENT: CLEAN AIR RESEARCH AS RELATED TO FOSSIL FUELS

LESSON PLAN CREATED BY:

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BACKGROUND INFORMATION

The United States Department of Energy Federal Energy Technology Center (FETC) manages the Nation's fossil energy research and development programs for coal and natural gas, while focusing on the development of technologies to use the nation's fossil energy resources more cleanly and efficiently.

A major research effort in the cleanup of flue gas, which is produced by the combustion of fossil fuels, is being conducted by the research program at the Federal Energy Technology Center. Technologies are being developed to lower sulfur dioxide (SO_2), nitrogen oxides (NO_X), hazardous air pollutants, and carbon dioxide (CO_2) emissions from flue gas. Past efforts have included low-temperature dry scrubbing SO_2 removal techniques that typically used a calcium-or sodium-based disposable sorbent either in a spray drying mode or in a duct injection mode of operation; novel techniques for enhancing sorbent utilization in conventional wet or dry scrubbing processes; and control of emissions produced from small-scale combustors (residential or commercial size) that burn coal or coal/sorbent briquettes.

Recent research at FETC has focused on the control of mercury emissions produced by burning various coals, sorbent processes to remove SO_2 and NO_X, and the capture utilization and storing of CO_2 removed from flue gas produced by fossil fuel combustion.

OBJECTIVES

- The students will be able to work in cooperative learning groups to study the effects of air pollutants and experimentation being conducted to eliminate them.
- The students will be able to explore the different types of careers in environmental science.
- The students will be able to apply decimals, fractions, and percents to compare the various components of air pollution.
- The students will be able to construct graphs to illustrate and compare the results of experimentation.
- The students will be able to gain an appreciation for the work done by scientists to solve energy and environmental problems.
- The students will be able to demonstrate knowledge of scientific vocabulary used in ocean sequestration of carbon dioxide which is produced by the combustion of fossil fuels.
- The students will be able to describe the advantages and disadvantages of ocean sequestration of carbon dioxide.

PROCEDURES

1. Students will be introduced to air pollution by setting up particulate collectors in various areas around the school grounds and examining their results.
2. Present background information to the students.

- By lecture and discussion, make students aware of air pollution problems within our environment caused by the burning of fossil fuels and the research conducted by the DOE in this area.

3. Introduce and discuss science and environmental vocabulary.
    - Present students with a glossary of terms.
    - Discuss the terms most relevant to the current lesson.
4. Students will research types of pollutants produced by the combustion of fossil fuels using various Internet sources (possible sites listed at end of lesson plan).
5. Working in small cooperative groups, students will compile information on these air pollutants: sulfur dioxide, nitrogen oxide, mercury levels in coal, and carbon dioxide. Students should be able to explain how the above pollutants contribute to the environmental problems and brainstorm on possible solutions to the problems.
6. Focusing on the control of CO_2 levels in the atmosphere, students will use the FETC Internet site to gather information about oceanic CO_2 sequestration as a possible solution to this problem.
7. Students will demonstrate through various lab activities some basic scientific principles involved in CO_2 sequestration.
    - Teacher demonstration of dry ice in water
    - Density differences of various substances
    - Solubility of CO_2 in various solutions

8. As a concluding activity, students can present the advantages and disadvantages of the possible solutions being researched for the control of CO_2 in the environment. (ex. – effectiveness, cost, feasibility, other environmental impacts, etc.)

ACTIVITIES

PARTICULATE COLLECTION:

- Prepare particulate collectors by cutting two windows in index cards.
- Cover each window with clear sticky tape.
- Hang or tape cards in different outdoor locations for at least two days.
- Use a microscope to observe the particles collected.

DRY ICE DEMONSTRATION:

- Drop dry ice into a column of water.
- Have students observe bubbles of CO_2 escaping to the surface.
- Have students conclude CO_2 sequestration is not a permanent solution.

DENSITY DIFFERENCES OF VARIOUS SUBSTANCES:

Use various liquids such as corn syrup, cooking oil, and vinegar.

Add food coloring to each liquid.

Place liquids in a large clear container.

Use various solids such as aluminum foil pellets, toothpick pieces, styrofoam pieces, pennies, etc..

Place solids into the liquid container.

Have students observe the arrangement of the different materials.

Have students draw conclusions about the relationship between density and the rate at which CO_2 will disperse when sequestered in the ocean.

SOLUBILITY OF CO_2 IN VARIOUS CONCENTRATIONS:

Have students prepare four different concentrations of water and carbonated water such as seltzer water. Suggested concentrations are:

0% water and 100% seltzer water

25% water and 75% seltzer water

50% water and 50% seltzer water

75% water and 25% seltzer water

Students will count surface bubbles for ten seconds, at one minute intervals, for ten minutes.

MATH CONNECTIONS

Have students apply decimals, fractions, and percents to compare the water to seltzer ratios.

Construct graphs to illustrate the results of these experiments.

VOCABULARY

CARBON DIOXIDE

CLEAN AIR ACT OF 1990

COMBUSTION

DENSITY

DRY SCRUBBING

FLUE GAS

FOSSIL FUEL

MERCURY

NITROGEN OXIDE

PARTICULATES

POLLUTANTS

SEQUESTRATION

SORBENT

SULFUR DIOXIDE

MATERIALS

ALUMINUM FOIL

COOKING OIL

CORN SYRUP

DRY ICE

FOOD COLORING

INDEX CARDS

MICROSCOPES

PAPER TOWELS

PELLETS

PENNIES

SELTZER WATER

STOPWATCH

STYROFOAM PIECES

TAPE

TOOTHPICKS

VINEGAR

WATER

SUGGESTED INTERNET RESOURCES

www.fetc.doe.gov

www.coolscience.com

earthshots:usgs

eelink:environmental education on the internet

epa.gov/airnow

whyfilesnews.wisc.edu